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RESEARCH ARTICLE

Preliminary results for the breeding bird atlas of Bucharest (Romania): Data from 2016–2023

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Abstract

Urban bird atlases offer solid information about the distribution and breeding status of birds and can help in urban planning, education, research, pest control, and many other fields of work. In Romania, the first urban atlas was completed for Cluj city in 2017. Our study offers solid information about breeding birds from the capital city, Bucharest, the biggest city in Romania. Fieldwork was conducted with the help of volunteers in the period of April–June, from 5:00 to 10:00 AM, starting in 2016 and lasting until 2023. Data was collected from squares of 1x1 km, summing a total of 159 complete squares from the 251 covering the whole city, with over 70.000 bird observations. Mobile apps were used for data collection and orientation inside the monitoring squares. Before the atlas study started, few bird observations were recorded; since 2016, thousands of observations have been made, with new species being discovered every year. Occasional observations and data from artificial nests were accepted too. Because of the small number of recorders, we divided the squares into two classes of importance: the main area, which includes the squares inside a buffer zone of 6 km from the city center, and a secondary area for the rest of the squares, focusing our efforts to finish the squares in the main area. More volunteers are needed, and also new approaches to collecting data on nocturnal and invasive species.

Keywords

bird distribution, ornithological atlas, breeding birds, urban bird conservation, citizen science.

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PENSOFT.

Introduction

Urbanization represents the shift of population from rural to urban areas; 30% of the human population lived in urban areas in the 1950s, and it is estimated that it will reach 68% by 2050 (United Nations 2018). It is a strong and rapidly expanding process all over the world (Lepczyk et al. 2016; Chen and Wang 2016), and it is considered to be one of the biggest reasons for species extinction (Czech et al. 2000), climate change, and environmental degradation (Lambin et al. 2001). Species richness decreases from rural to urban centers (Faeth et al. 2011); however, adapted species will be more abundant (Garaffa et al. 2009; Møller 2012). Some bird species thrive in urban areas; these are most likely synurbic species, which benefit from human settlements and waste. Urbanization influences animals in different ways, and so they respond differently, as classified by Fischer et al. (2015) as urban avoiders, urban utilizers, and urban dwellers. It has been shown that in temperate areas, species that use cavities for nesting are more likely to be seen in urban areas; the same is true for those that are omnivorous or granivorous (Chace and Walsh 2006). For some humans living in urban areas, the birds they see near their homes or in city parks could be the only contact they have with wildlife. Some will appreciate this and try to keep them close by feeding the birds or installing artificial nests, but in some cases, some species present a health issue due to their feces or because they could easily transmit diseases. The most common bird species seen in cities are the feral pigeon, the house sparrow, the starling, and the swallow (Aronson et al. 2014). Urban areas could be easily inhabited by non-native species, competing for food or nesting sites with local species. Such a species is the rose-ringed parakeet *Alexandrinus krameri*, the most abundant parrot species in Europe, with populations in some cities starting from just a few hundred individuals to over 5000 birds (Pârâu et al. 2016). For Europe, it is considered to be one of the worst 100 alien species (Drake 2009). Monitoring and keeping control of alien species is an important aspect of native wildlife conservation.

Until now, data has not been collected in a systematic way for the city of Bucharest. There are several scientific works that show the presence of certain species in the city; more than 160 species were reported between 1951 and 1988 (Papadopol and Petrescu 1991); another study shows the presence of 135 species in the years 1991 and 2006 (Dragoș et al. 2017). The nesting of several species is confirmed through the analysis of nest collections at the natural history museum "Grigore Antipa" (Petrescu 2005). Other studies and short papers show the presence of certain species in the city, some of which were not observed in previous studies (Giurgincă 1993; Papadopol 1993; Giurgincă 1994a; Giurgincă 1994b; Giurgincă 1994c; Giurgincă 1994d; Giurgincă 1994e; Giurgincă 1996; Giurgincă 2002; Giurgincă and Vănoaica 2002; Giurgincă 2004).

Mapping species distributions by the Atlas method has been a common practice for half a century (Luniak 2017). The first ornithological atlas was made in 1970 for the West Midlands region of England (Lord and Munns 1970), and the first city atlas was accomplished for the London area (Montier 1977), even though it covers

a huge surface that includes even rural areas. In Europe, until 2014, there were 77 known urban atlases for 66 towns and cities, with Italy being the leader with 44 atlases, followed by Poland with 12 and Germany with 8 (Luniak 2017). Cluj was the first city in Romania to have a bird atlas (Kósa et al. 2017). Information on the maps varies from one atlas to another. It can offer information about the breeding status, season of occurrence, bird numbers, distribution in habitats, or changes in occurrence (Luniak 2017).

Urban ornithological atlases can be used in general for describing avifauna in cities. Dunn and Weston (2008), in a review of 270 ornithological atlases, describe 15 ways in which information presented in atlases can be applied. Some of these applications are education and recreation, environmental impact assessments, land-use planning, conservation planning, pest-control planning, or risk assessment for introduced species. The aim of the study is to show the situation of the Breeding Bird Atlas of Bucharest, a project led by the Romanian Ornithological Society (SOR), by analyzing the data collected in the last 8 years and by highlighting the nesting species. In future studies, after completing the data collection, the authors plan to create distribution maps and evaluate the numbers of nesting pairs for each species.

Materials and methods

Study area

Bucharest is the capital of Romania, and it is located in the southern part of the country (44°25'36.53"N 26°6'9.52"E). According to a report made by the National Institute of Statistics (INS 2024), the city has a population of 2.149.018 inhabitants and a surface area of 239 km^2. It has a continental climate with an annual precipitation of 615 mm and a mean annual temperature of 10–11°C (Ioja, 2009).

To collect data in a systematic manner, we divided Bucharest into squares of 1x1 km (1 km^2), resulting in a total of 251 squares. Some of the squares, from the edge of the study area, overlap in a small percentage with Ilfov County. Squares were classified into two areas of importance: the main area, squares inside a 6 km buffer radius from the center of the city (109 squares), and a secondary area, the rest of the squares till the border with Ilfov County. Inside the 6 km buffer radius are the most important green areas of the city, parks and lakes, as well as the area with the highest density of construction, making it the urban core of the city.

Fieldwork

Data was collected in three main ways: standard visits, occasional observations, and artificial nest monitoring. A standard visit is a one-hour search inside the 1x1 km square, during which the observer is moving freely inside the square, trying to cover as much as possible and to record every bird observed or heard. For the recording of observations, in the period 2016 – 2020, we used the free mobile app ObsMapp, which is connected to the online database Observation.org (2024). Starting from 2021,

Ornitodata mobile app was used. Using an electronic device as a mobile phone and storing the data immediately in a secure online database was a key element for a fast and safe recording of the data. Every observation included the species name, number, activity, and plumage. Automatically, the app gives additional information like the GPS coordinates and the date and time of the observation. Every observer had an account where they stored their data, and at the end of the fieldwork period, they were sending the data in a csv file to the project coordinator. The data was introduced in Ornitodata (SOR 2024b), an online database of the Romanian Ornithological Society (SOR), to unify the old data with the new one. For each square, there were two visits made in the period April–May, one for each month, between 5:00 and 10:00 AM. Observations were made only in good weather conditions, with no rain or a wind speed lower than 3 on the Beaufort scale. Standard visits have the role of identifying the breeding species and establishing the number of breeding pairs for each species identified. Also, it gives solid information about the distribution and activity of the species inside the square.

Occasional observations are those made in any month and at any hour. This type of data helps complete the image of species found in Bucharest and their distribution. Data was accepted even for migratory or wintering birds for a better understanding of the ecological status and importance of the city for wild birds. As with the standard visits, data was recorded with the help of ObsMapp app or Ornitodata app, and directly introducing the information in Ornitodata database.

Artificial nest monitoring offers clear information about breeding species in the parks inside the city. More than 100 nests have been installed in the parks since 2016, and the monitoring began in 2017. Volunteers visited the nests once a week in April–May, summing 8 visits for one nest. Visits lasted for 20 minutes during the day, during which the observer was recording if the nest was occupied or not, what species occupied the nest, and information about threats and anthropogenic pressures. In the first years, the information was noted on a special form, which was sent at the end of the fieldwork to the project coordinator to introduce the data into the database. Since 2021 Ornitodata app was used.

Statistical and spatial analysis

Because the data is stored in an online database, it is easier to export the whole data or preferential data by period or species. It can be exported as csv, kml, or xlsx files, and after being processed in GIS software, QGis (2024) was the main tool for spatial and statistical analysis used for the project.

Results

Volunteers have a very important role in the project, and with their help, we were able to collect all the data. Before the Atlas project, there were between 1 and 6 observers per year collecting occasional observations. Since 2016, there has been an increase

in interest, and more observers have collected occasional and standard observations, from 13 observers in 2016 to 79 in 2023. A similar situation can be observed for the number of bird species seen in Bucharest, from a few dozen to over one hundred species seen in the atlas period (Fig. 1). Until the end of 2023, 234 bird species were recorded in SOR´s database for Bucharest, 188 bird species in April–May from 2016–2023 (Table 1). The most common species recorded during the period of the project are *Passer domesticus, Sturnus vulgaris, Streptopelia decaocto, Turdus merula, Columba livia forma domestica, Corvus corone cornix, Parus major, Pica pica, Apus apus* and *Columba palumbus*.

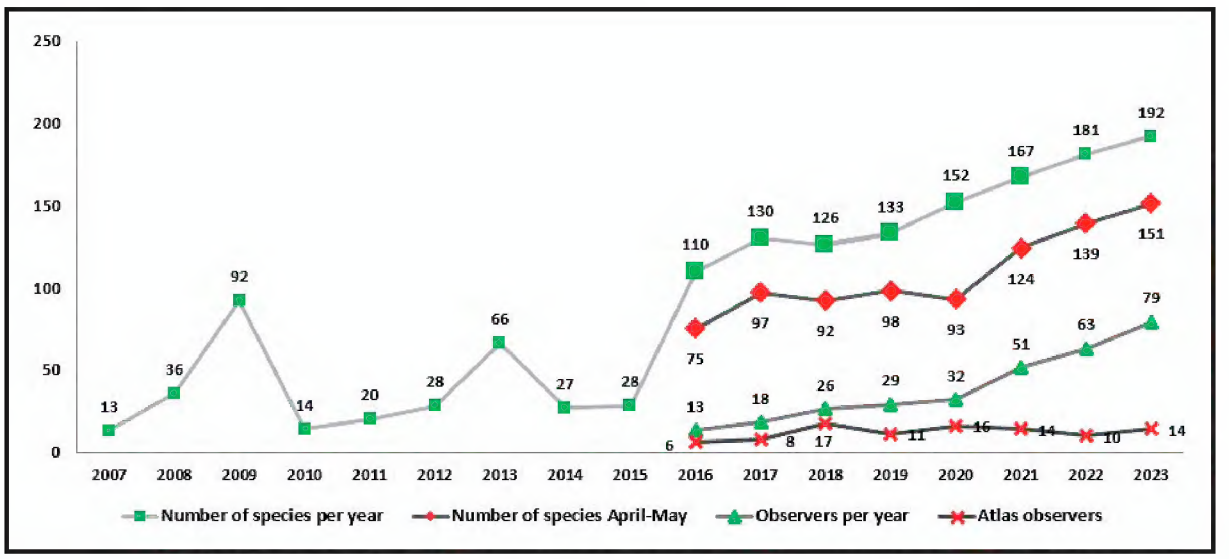

Figure 1. Number of bird species seen for each year and for the period of April–May, corelated with the number of observers, according to the SOR online database.

The project brought an explosion of observations on birds in the Bucharest area. An analysis of all official SOR data (SOR 2024b) on the Bucharest area shows that the first observations were made in 2007, 49 observations through the Common Bird Monitoring (CBM) program (SOR 2024a), followed by occasional observations and other CBM observations, summing up about 1000 observations at the end of 2015. In 2016, the first standardized observations were made for the project Breeding Birds Atlas of Bucharest, held by the SOR. More than 3000 observations were made that year, with numbers increasing for the following years of data collection for the Atlas (Fig. 2).

At the end of 2023, we had 159 complete squares with the two standard visits and one other square with one visit (Fig. 3). The rest of the squares will be covered in the years to come.

Due to the heterogeneous structure of the city, the distribution of species in the city differs from one square to another, as does the richness of species, as can be seen in the species richness map (Fig. 4). The areas richest in species, with over 100 different species (black squares), are located in areas with large and complex urban parks, such as Văcărești Natural Park, Tineretului Park and Morii Lake. This diversity

Table 1. Species observed in April-May 2016–2023.

Order	Family	No.	Scientific name	Fenology	2016	2017	2018	2019	2020	2021	2022	2023	2023 IUCN Red List category
Galliformes	Phasianidae	1	*Coturnix coturnix*	B	✔				✔		✔	✔	LC
		2	*Phasianus colchicus*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
Anseriformes	Anatidae	3	*Cygnus olor*	B	✔	✔		✔	✔	✔	✔	✔	LC
		4	*Anser albifrons*	P			✔						LC
		5	*Bucephala clangula*	W								✔	LC
		6	*Tadorna tadorna*	P								✔	LC
		7	*Netta rufina*	P								✔	LC
		8	*Aythya ferina*	B	✔	✔	✔	✔	✔	✔	✔	✔	VU
		9	*Aythya nyroca*	B	✔	✔	✔	✔	✔	✔	✔	✔	NT
		10	*Spatula querquedula*	P	✔	✔	✔	✔		✔	✔	✔	LC
		11	*Spatula clypeata*	P			✔	✔		✔	✔	✔	LC
		12	*Mareca strepera*	P							✔	✔	LC
		13	*Mareca penelope*	P						✔	✔	✔	LC
		14	*Anas platyrhynchos*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		15	*Anas crecca*	P				✔			✔	✔	LC
Podicipediformes	Podicipedidae	16	*Tachybaptus ruficollis*	B				✔	✔	✔	✔	✔	LC
		17	*Podiceps grisegena*	P								✔	LC
		18	*Podiceps cristatus*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		19	*Podiceps nigricollis*	P			✔	✔	✔	✔	✔	✔	LC
Columbiformes	Columbidae	20	*Columba livia forma domestica*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		21	*Columba palumbus*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		22	*Streptopelia turtur*	P		✔							VU
		23	*Streptopelia decaocto*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
Caprimulgiformes	Caprimulgidae	24	*Caprimulgus europaeus*	P	✔					✔		✔	LC
	Apodidae	25	*Tachymarptis melba*	P								✔	LC
		26	*Apus pallidus*	B*								✔	LC
		27	*Apus apus*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
Cuculiformes	Cuculidae	28	*Cuculus canorus*	B	✔		✔	✔	✔	✔	✔	✔	LC
Gruiformes	Rallidae	29	*Rallus aquaticus*	B				✔		✔	✔	✔	LC
		30	*Crex crex*	P							✔		LC
		31	*Zapornia parva*	P							✔		LC
		32	*Gallinula chloropus*	B	✔	✔		✔	✔	✔	✔	✔	LC
		33	*Fulica atra*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
Gaviiformes	Gaviidae	34	*Gavia arctica*	W					✔	✔			LC
Ciconiiformes	Ciconiidae	35	*Ciconia nigra*	P					✔	✔	✔	✔	LC
		36	*Ciconia ciconia*	B	✔		✔	✔	✔	✔	✔	✔	LC
Pelecaniformes	Threskiornithidae	37	*Plegadis falcinellus*	P							✔	✔	LC
	Ardeidae	38	*Ixobrychus minutus*	B					✔	✔	✔	✔	LC
		39	*Nycticorax nycticorax*	P	✔	✔	✔	✔	✔	✔	✔	✔	LC
		40	*Ardeola ralloides*	P							✔		LC
		41	*Ardea cinerea*	P			✔	✔	✔	✔	✔	✔	LC
		42	*Ardea purpurea*	P		✔		✔		✔	✔		LC
		43	*Ardea alba*	P								✔	LC
		44	*Egretta garzetta*	P				✔	✔	✔	✔	✔	LC
	Pelecanidae	45	*Pelecanus crispus*	P								✔	NT
		46	*Pelecanus onocrotalus*	P					✔		✔		LC
Suliformes	Phalacrocoracidae	47	*Microcarbo pygmaeus*	P		✔		✔	✔	✔	✔	✔	LC
		48	*Phalacrocorax carbo*	P	✔	✔	✔	✔	✔	✔	✔	✔	LC

Table 1. (continued)

Order	Family	No.	Scientific name	Fenology	2016	2017	2018	2019	2020	2021	2022	2023	2023 IUCN Red List category
Charadriiformes	Recurvirostridae	49	*Himantopus himantopus*	B		✔	✔		✔	✔	✔	✔	LC
	Charadriidae	50	*Charadrius dubius*	B						✔	✔	✔	LC
		51	*Vanellus vanellus*	P							✔	✔	NT
	Scolopacidae	52	*Numenius arquata*	P							✔		NT
		53	*Calidris pugnax*	P							✔	✔	LC
		54	*Calidris ferruginea*	P								✔	NT
		55	*Calidris minuta*	P							✔		LC
		56	*Scolopax rusticola*	P						✔	✔		LC
		57	*Gallinago media*	P							✔		NT
		58	*Gallinago gallinago*	P							✔		LC
		59	*Actitis hypoleucos*	P			✔	✔		✔	✔	✔	LC
		60	*Tringa ochropus*	P				✔		✔	✔		LC
		61	*Tringa erythropus*	P						✔			LC
		62	*Tringa nebularia*	P							✔	✔	LC
		63	*Tringa glareola*	P							✔	✔	LC
	Laridae	64	*Hydrocoloeus minutus*	P							✔		LC
		65	*Larus ridibundus*	B	✔		✔	✔	✔	✔	✔	✔	LC
		66	*Larus canus*	W/P				✔				✔	LC
		67	*Larus fuscus*	W/P						✔	✔	✔	LC
		68	*Larus michahellis*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		69	*Larus cachinnans*	W/P			✔			✔			LC
		70	*Chlidonias hybrida*	B	✔	✔	✔		✔	✔	✔	✔	LC
		71	*Chlidonias leucopterus*	P						✔		✔	LC
		72	*Chlidonias niger*	P				✔		✔	✔	✔	LC
		73	*Sterna hirundo*	B	✔		✔	✔	✔	✔	✔	✔	LC
Strigiformes	Strigidae	74	*Athene noctua*	B	✔	✔		✔	✔	✔	✔	✔	LC
		75	*Otus scops*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		76	*Asio otus*	B	✔	✔	✔			✔	✔	✔	LC
		77	*Strix aluco*	B		✔			✔				LC
Accipitriformes	Pandionidae	78	*Pandion haliaetus*	P			✔						LC
	Accipitridae	79	*Pernis apivorus*	P							✔	✔	LC
		80	*Circaetus gallicus*	P		✔							LC
		81	*Clanga pomarina*	P	✔			✔	✔	✔		✔	LC
		82	*Hieraaetus pennatus*	P								✔	LC
		83	*Circus aeruginosus*	B	✔	✔	✔	✔	✔		✔	✔	LC
		84	*Circus cyaneus*	P	✔							✔	LC
		85	*Circus pygargus*	P		✔							LC
		86	*Accipiter brevipes*	B						✔	✔	✔	LC
		87	*Accipiter nisus*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		88	*Accipiter gentilis*	P								✔	LC
		89	*Haliaeetus albicilla*	P						✔			LC
		90	*Milvus migrans*	P					✔			✔	LC
		91	*Buteo buteo*	P					✔	✔	✔	✔	LC
Bucerotiformes	Upupidae	92	*Upupa epops*	P				✔	✔	✔	✔	✔	LC
Coraciiformes	Meropidae	93	*Merops apiaster*	P				✔	✔	✔	✔	✔	LC
	Coraciidae	94	*Coracias garrulus*	P								✔	LC
	Alcedinidae	95	*Alcedo atthis*	B					✔	✔	✔	✔	LC

Table 1. (continued)

Order	Family	No.	Scientific name	Fenology	2016	2017	2018	2019	2020	2021	2022	2023	2023 IUCN Red List category
Piciformes	Picidae	96	*Jynx torquilla*	B						✔	✔	✔	LC
		97	*Picus canus*	B		✔		✔		✔	✔		LC
		98	*Picus viridis*	B	✔			✔	✔	✔	✔	✔	LC
		99	*Leiopicus medius*	B			✔	✔		✔	✔	✔	LC
		100	*Dryobates minor*	B				✔		✔	✔	✔	LC
		101	*Dendrocopos syriacus*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		102	*Dendrocopos major*	B	✔		✔	✔	✔	✔	✔	✔	LC
Falconiformes	Falconidae	103	*Falco tinnunculus*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		104	*Falco vespertinus*	P					✔			✔	VU
		105	*Falco columbarius*	W						✔			LC
		106	*Falco subbuteo*	B	✔		✔	✔	✔	✔	✔	✔	LC
		107	*Falco peregrinus*	W	✔		✔		✔			✔	LC
Psittaciformes	Psittacidae	108	*Alexandrinus krameri*	B	✔			✔	✔	✔	✔	✔	LC
Passeriformes	Oriolidae	109	*Oriolus oriolus*	B	✔		✔	✔	✔	✔	✔	✔	LC
	Laniidae	110	*Lanius collurio*	B	✔	✔		✔	✔	✔	✔	✔	LC
	Corvidae	111	*Garrulus glandarius*	B				✔		✔	✔	✔	LC
		112	*Pica pica*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		113	*Corvus monedula*	B	✔		✔	✔	✔	✔	✔	✔	LC
		114	*Corvus frugilegus*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		115	*Corvus corax*	P				✔					LC
		116	*Corvus corone cornix*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
	Paridae	117	*Poecile palustris*	P							✔		LC
		118	*Cyanistes caeruleus*	B	✔	✔		✔	✔	✔	✔	✔	LC
		119	*Parus major*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
	Remizidae	120	*Remiz pendulinus*	B	✔	✔		✔		✔	✔	✔	LC
	Alaudidae	121	*Alauda arvensis*	B			✔					✔	LC
		122	*Galerida cristata*	B						✔		✔	LC
	Panuridae	123	*Panurus biarmicus*	B	✔			✔			✔	✔	LC
	Acrocephalidae	124	*Hippolais icterina*	B	✔				✔	✔	✔	✔	LC
		125	*Acrocephalus schoenobaenus*	B	✔	✔	✔	✔		✔	✔	✔	LC
		126	*Acrocephalus palustris*	B		✔	✔	✔	✔	✔	✔	✔	LC
		127	*Acrocephalus scirpaceus*	B	✔	✔	✔	✔		✔	✔	✔	LC
		128	*Acrocephalus arundinaceus*	B	✔		✔	✔	✔	✔	✔	✔	LC
	Locustellidae	129	*Locustella luscinioides*	B	✔	✔	✔	✔		✔	✔	✔	LC
		130	*Locustella fluviatilis*	P				✔				✔	LC
	Hirundinidae	131	*Delichon urbicum*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		132	*Cecropis daurica*	P					✔				LC
		133	*Hirundo rustica*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		134	*Riparia riparia*	P			✔	✔		✔	✔	✔	LC
	Phylloscopidae	135	*Phylloscopus sibilatrix*	P			✔	✔	✔	✔	✔	✔	LC
		136	*Phylloscopus trochilus*	P				✔	✔	✔	✔	✔	LC
		137	*Phylloscopus collybita*	B	✔	✔		✔	✔	✔	✔	✔	LC
		138	*Phylloscopus tristis*	P								✔	LC
	Aegithalidae	139	*Aegithalos caudatus*	B					✔		✔	✔	LC
	Sylviidae	140	*Sylvia atricapilla*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		141	*Curruca nisoria*	P						✔			LC
		142	*Curruca curruca*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		143	*Curruca communis*	B	✔				✔	✔	✔	✔	LC

Table 1. (continued)

Order	Family	No.	Scientific name	Fenology	2016	2017	2018	2019	2020	2021	2022	2023	2023 IUCN Red List category
Passeriformes	Certhiidae	144	*Certhia familiaris*	B							✔	✔	LC
	Sittidae	145	*Sitta europaea*	B	✔		✔	✔	✔	✔	✔	✔	LC
	Troglodytidae	146	*Troglodytes troglodytes*	W				✔	✔	✔	✔	✔	LC
	Sturnidae	147	*Sturnus vulgaris*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		148	*Pastor roseus*	P						✔			LC
	Turdidae	149	*Turdus viscivorus*	P						✔			LC
		150	*Turdus philomelos*	B			✔	✔		✔	✔	✔	LC
		151	*Turdus iliacus*	W							✔	✔	NT
		152	*Turdus merula*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		153	*Turdus pilaris*	P						✔			LC
		154	*Turdus torquatus*	P							✔		LC
	Muscicapidae	155	*Muscicapa striata*	B	✔			✔	✔	✔	✔	✔	LC
		156	*Erithacus rubecula*	B				✔	✔	✔	✔	✔	LC
		157	*Luscinia luscinia*	P	✔	✔					✔	✔	LC
		158	*Luscinia megarhynchos*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		159	*Ficedula parva*	P				✔	✔	✔	✔	✔	LC
		160	*Ficedula hypoleuca*	P					✔	✔	✔	✔	LC
		161	*Ficedula albicollis*	B		✔	✔	✔	✔	✔	✔	✔	LC
		162	*Phoenicurus ochruros*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		163	*Phoenicurus phoenicurus*	B	✔		✔	✔	✔	✔	✔	✔	LC
		164	*Saxicola rubetra*	P						✔	✔	✔	LC
		165	*Saxicola torquatus*	P						✔			LC
		166	*Oenanthe oenanthe*	P								✔	LC
	Regulidae	167	*Regulus regulus*	P					✔	✔	✔	✔	LC
		168	*Regulus ignicapilla*	P						✔	✔	✔	LC
	Prunellidae	169	*Prunella modularis*	P						✔		✔	LC
	Passeridae	170	*Passer domesticus*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		171	*Passer montanus*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
	Motacillidae	172	*Anthus trivialis*	P				✔				✔	LC
		173	*Motacilla flava*	B			✔	✔	✔	✔	✔	✔	LC
		174	*Motacilla cinerea*	W						✔	✔		LC
		175	*Motacilla citreola*	P								✔	LC
		176	*Motacilla alba*	B				✔	✔	✔	✔	✔	LC
	Fringillidae	177	*Fringilla coelebs*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		178	*Fringilla montifringilla*	W							✔		LC
		179	*Coccothraustes coccothraustes*	B					✔		✔	✔	LC
		180	*Pyrrhula pyrrhula*	P							✔		LC
		181	*Chloris chloris*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		182	*Linaria cannabina*	P								✔	LC
		183	*Carduelis carduelis*	B	✔	✔	✔	✔	✔	✔	✔	✔	LC
		184	*Serinus serinus*	P			✔	✔					LC
		185	*Spinus spinus*	W	✔			✔	✔			✔	LC
	Emberizidae	186	*Emberiza calandra*	B			✔			✔	✔	✔	LC
		187	*Emberiza hortulana*	P								✔	LC
		188	*Emberiza schoeniclus*	B				✔			✔		LC

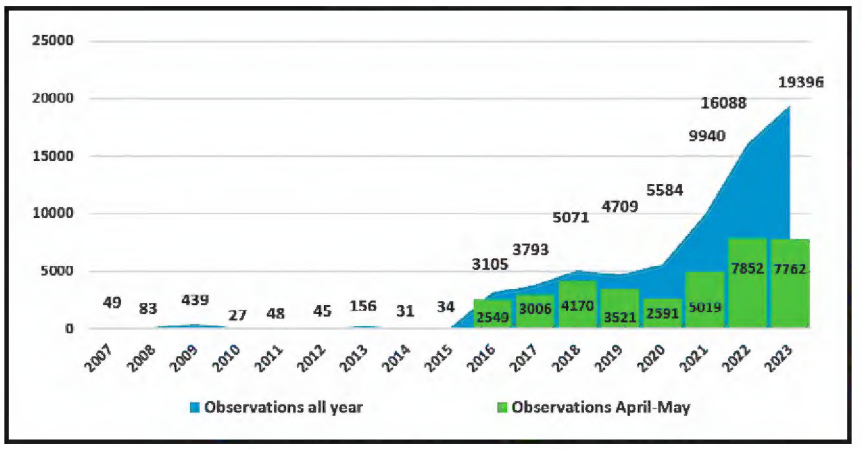

Figure 2. Data from Ornitodata (online database of SOR) showing the number of bird observations for Bucharest starting 2007. Since 2016, there is a dramatic increase in observations thanks to the project.

of species from the locations mentioned above is also known by the observers, many occasional observations come from these areas, according to the heatmap in Fig. 5.

A basic element for each type of atlas is the map. After the completion of data collection from all squares, distribution maps will be made for each nesting species in the city, as shown in the preliminary model for *Otus scops* and *Pica pica* species (Fig. 6).

Many other observations have come from the SOR´s artificial nest monitoring scheme, from nestsboxes located in the city parks. The tree sparrow (*Passer montanus*) is the most common species in artificial nests, followed by the house sparrow (*Passer domesticus*), the great tit (*Parus major*), the common redstart (*Phoenicurus phoenicurus*), and the blue tit (*Cyanistes caeruleus*). On one occasion, a scops owl

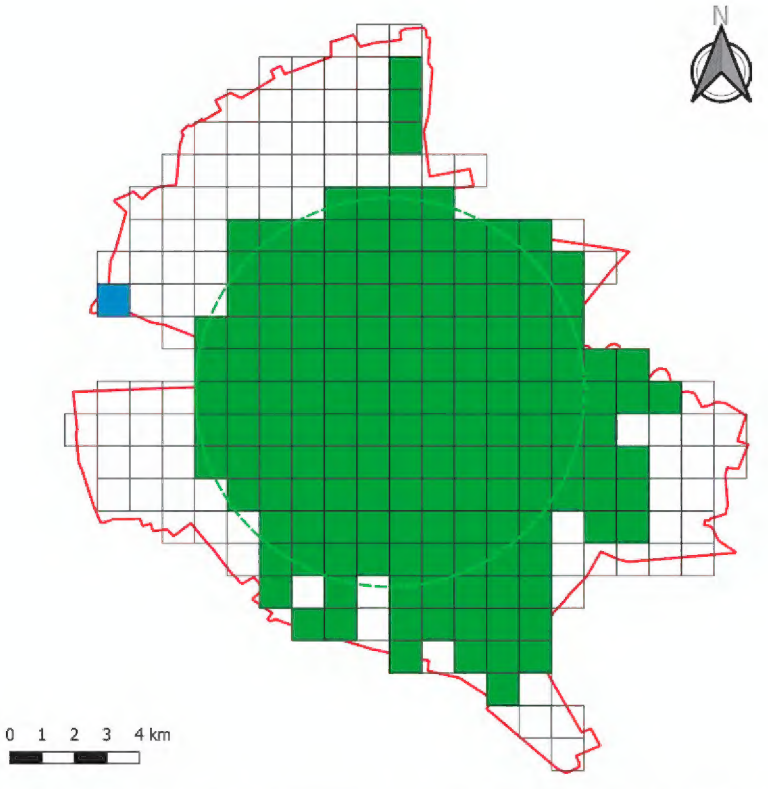

Figure 3. Distribution of complete squares in green and squares with only one visit in blue. Squares inside the 6 km buffer zone are a priority.

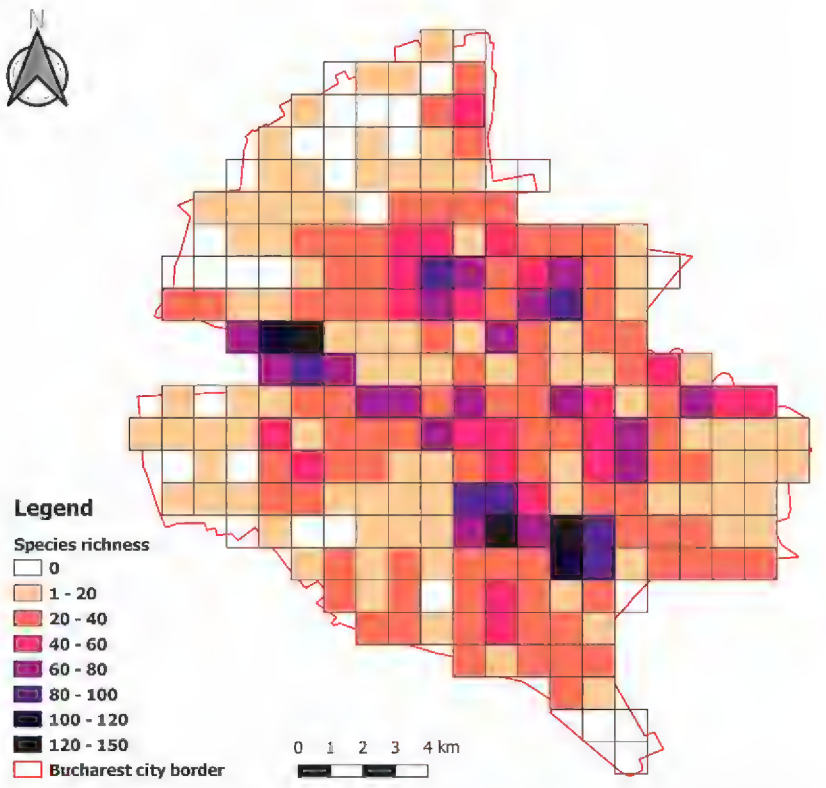

Figure 4. Species richness by cell of 1 x 1 km. Squares with 0 species were never visited in the period 2016–2023.

(*Otus scops*) was seen flushing from an artificial nest, but the use of the artificial nest is uncertain. In the autumn period, we are sanitizing the nests and gathering new data about their use.

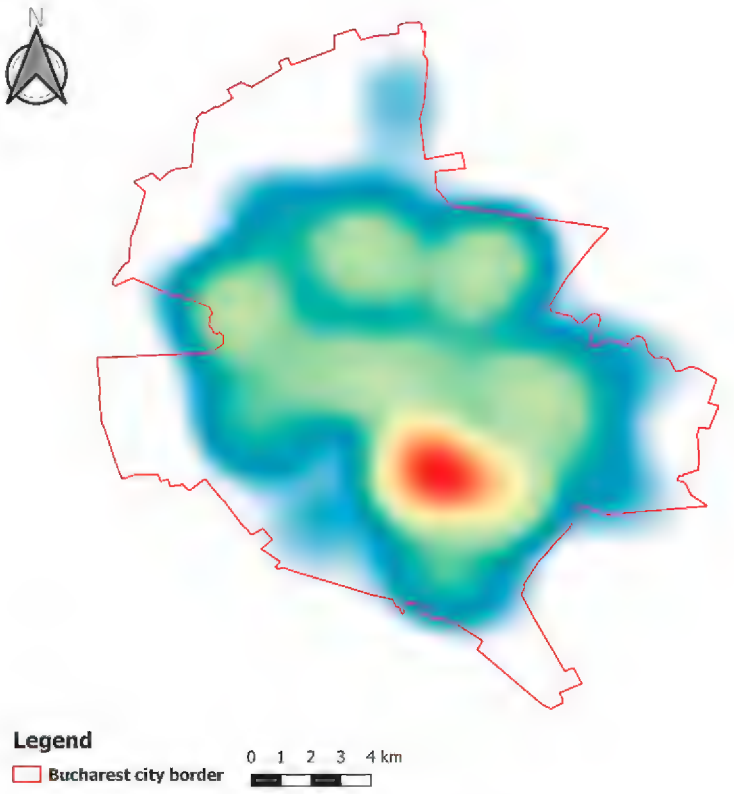

Figure 5. Heatmap showing the abundance of observations for the period 2016–2023.

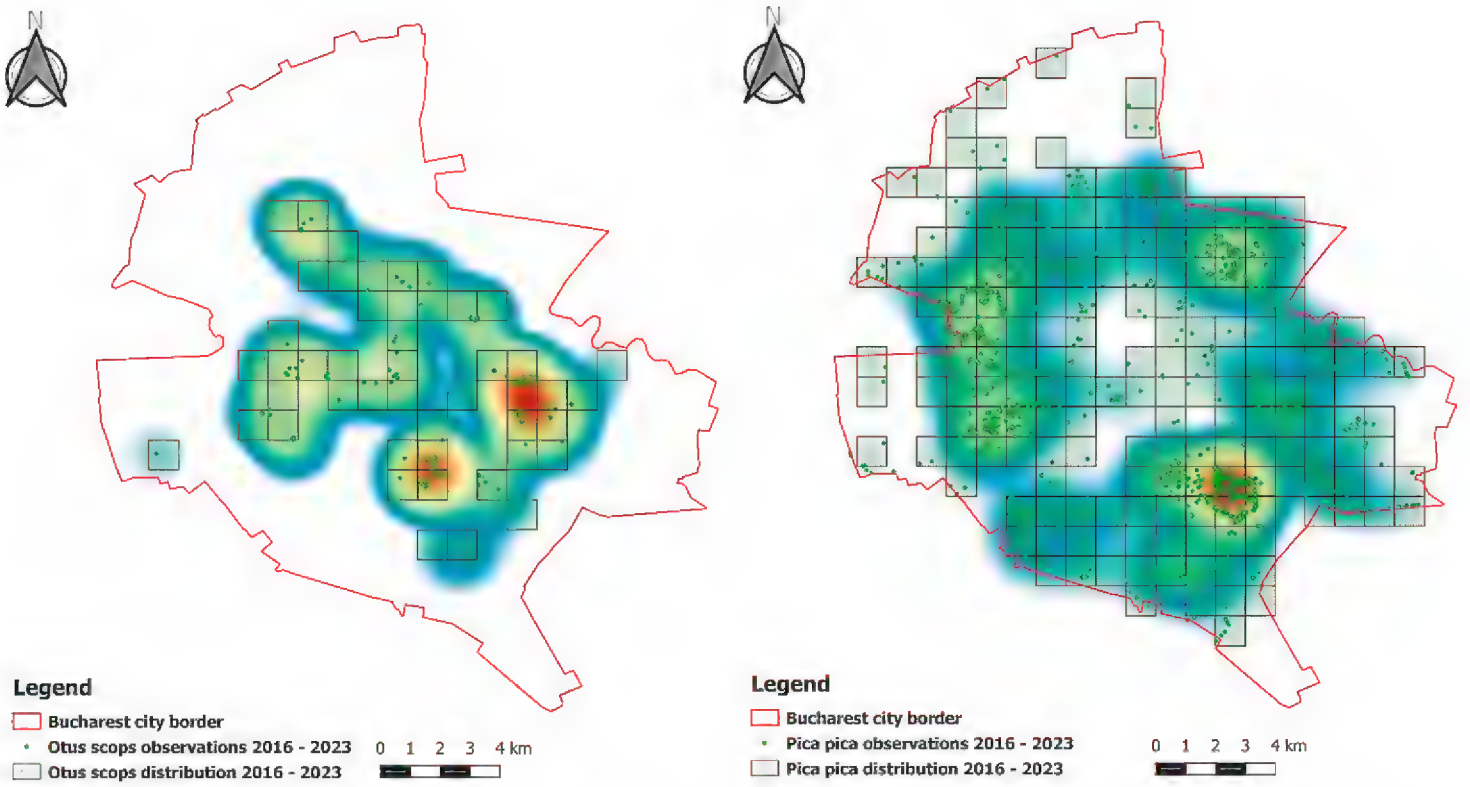

Figure 6. Preliminary distribution maps for *Otus scops* (left map) and *Pica pica* (right map).

Discussion

The first urban ornithological atlas in Romania was accomplished for Cluj by the SOR members and volunteers in 2017 (Kósa et al. 2017). For Bucharest, our atlas will be the first of its kind, offering the first evaluation of the urban avifauna. The atlas will contain information about the breeding species present in Bucharest, the minimum number of pairs per square and distribution. Additional information will be included for nonbreeding species present in the passage or wintering periods. Compared to Cluj, which has an area of 180 km^2, Bucharest is much larger, with 240 km^2, and is located in the southern part of the country on the migration route of many species of birds. Until now, we can confirm the presence of 89 breeding species in Bucharest, compared to 75 in Cluj (Kósa et al. 2021). For Bucharest, during the period April–May 2016–2023, another 86 passage species were observed, 9 wintering species, 3 species wintering/passage, and one with uncertain breeding status (*Apus pallidus*) (Fig. 7).

When we look at the data collected from the last 8 years, we can say without hesitation that the area with the most diverse habitat but also the greatest abundance of bird species is Văcărești Natural Park. With approximately 150 species present during the nesting and passage periods and around 170 species throughout the whole year, this is a real hotspot for birds. Not far from Văcărești Natural Park is Tineretului Park, a large park with a lake and diverse vegetation. The area is very frequented by birdwatchers, who have observed up to 138 species of wild birds here. A unique area for the city is Morii Lake, an artificial lake with concrete banks that hosts tens of thousands of seagulls and ducks during the winter. Rare species for the

fauna of Romania were observed here, such as *Larus delawarensis*, *Xema sabini*, *Larus hyperboreus*, or *Gavia immer*. The species richness map from Fig. 4 reveals not only the most iconic birding areas that we already mentioned but also other areas that could host between 60 and 100 bird species. These areas are other parks with complex vegetation and water bodies, attracting and hosting diverse wildlife.

From the total of 188 species observed during the standard data collection period for the atlas, April–May 2016–2023, 3 species are vulnerable (VU), another 7 are near threatened (NT), and 178 are least concern (LC), according to the 2023 IUCN Red List (Fig. 8).

Not everything went according to plan. Since the first year, we had a major problem with the lack of participants (7), making the data gathering a very slow process because not all of them were available to gather data according to the methodology. The same happened in 2017 with 6 observers, and in 2018, the number was 17, the highest number yet of observers collecting data according to the methodology. Taking into account the surface of the study area (251 km^2) the number of participants is very small compared to other urban ornithological atlases. For Brussels with a surface of 162 km^2 there were 130 recorders (Rabosee et al. 1995), for Praque-532 km^2-154 recorders, Venice-414 km^2-155, Amsterdam-432 km^2-103, Hamburg-747 km^2-89, Moscow-972 km^2-112 collected standardized data from the grid cells but 313 people supplied data (Luniak 2017). Exceptions are Berlin with only 40 recorders for a surface of 892 km^2 (Otto and Witt 2002) and Voronezh with a surface of 189 km^2 which had 11 recorders but accepted data from some 400 people (Luniak 2017). In the case of Cluj, 27 km^2 with squares of 500x500 m, were evaluated in 4 years by 15 recorders (Kósa et al. 2017).

The weather played an important role in the process of data gathering. Rainy days are a common phenomenon in the spring, making us lose valuable time by postponing visits to the squares. Another issue in data gathering is the sound pollution characteristic of big cities. The traffic starts at an early hour (7:00 AM), creating a barrier to sound detection and obliging the participant to start at an earlier hour, but not everyone is willing to do so. Sound pollution is known to be a reason for city

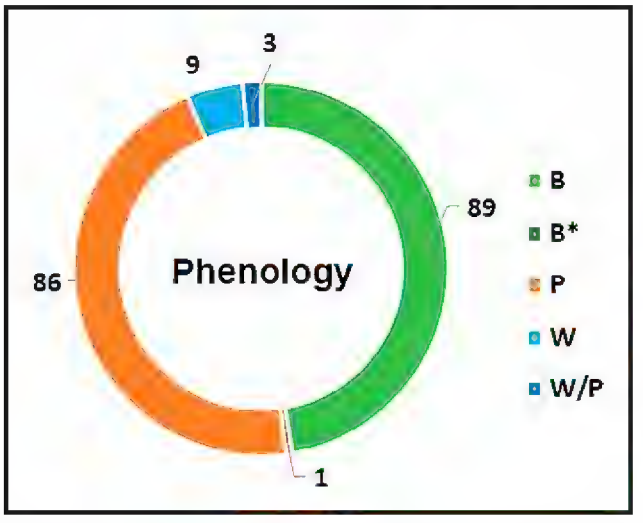

Figure 7. Phenology of observed species from April–May 2016–2023.

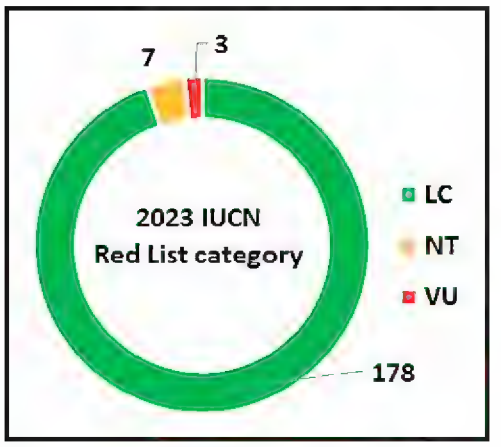

Figure 8. Species status according to 2023 IUCN Red List.

birds to make changes in their singing, being constrained to sing faster and with a higher pitch so they can make themselves heard (Slabbekoorn and Boer-Visser 2006; Nemeth and Brumm 2010). Some squares were covered only in a small percentage because of their limited access, covering private or closed areas, leading to a lack of information about species numbers and abundance. In 2016 and 2017, we tried to cover the squares in a standard way, even at night after two hours from sunset, so we could identify nocturnal species like owls. We had to quit the idea due to poor results and safety reasons for the participants, but we accept occasional observations of nocturnal species.

The duration of fieldwork can differ from atlas to atlas according to the surface of the study and the number of recorders. From 1–2 years (seasons) to 3–4 years or 5–10 years, with some exceptions, even 12 years (Luniak 2017). At the start of the project, we thought that many recorders would be involved, and in 3–4 years, we will finish the fieldwork for our atlas. With eight years already gone, we anticipate that we need three more years to finish gathering data from the whole city.

For mapping records, various systems are used; the most common one is the UTM Grid (Universal Transverse Mercator), which is a flat projection of a geographic region divided into squares, compensating for the convexity of the earth's surface, and atlases have different UTM grid sizes from 500 x 500 m to 1 x 1 km or 2 x 2 km (Luniak 2017; Gibbons et al. 2007). We considered that the UTM grid of 1 x 1 km (1 km^2) was the most appropriate for Bucharest. Some atlases have data collected from other types of grids, like rectangular cells, based on geographical coordinates or irregular units (Luniak 2017).

Conclusion

This will be the first urban bird atlas for Bucharest, offering strong information about the breeding bird species. The project has helped to increase the number of bird observations since 2016 by thousands of observations per year. Not only professional recorders were involved, but volunteers played an important role in data collection

by covering new areas. Still, there is a need for a higher number of participants with pronounced involvement to cover the rest of the squares.

We are aware of the lack of data for nocturnal, shy, or invasive species, and to compensate for this, we are planning to use various devices that can help us record these groups of species. In the next years of data gathering, we will install audio recorders like AudioMoth (Hill et al. 2017) in the parks and other big green areas of the city. For monitoring invasive species, we started a local monitoring scheme for the small population of rose-ringed parakeet *Alexandrinus krameri* from Tineretului Park. Occasional observations of the invasive species have been recorded with the help of volunteers since 2016.

The Atlas may have influences in fields such as research and education and can be a tool for planning strategies for species conservation, but it can also influence decision-making that has an impact on the city we live in, the type of construction, the conservation of green areas, or pesticides used. Through each of these areas, ideas can arise as to how the atlas can solve problems. The atlas also provides support for those who want to develop their passion for birdwatching. The inhabitants of the city will learn more about the species with the possibility of seeing them where they know they are, according to the distribution maps. They will want to bring them closer to their homes by installing artificial nests and feeders, thereby preserving or increasing the number of birds. Through the Breeding Bird Atlas of Bucharest, SOR can attract even more members and volunteers by carrying out activities that are within their reach.

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